

REMARKS

Applicants gratefully acknowledge the courtesy of a personal interview granted to assignee's representatives James M. Heintz and Philippe Schick by Examiner Wilson on December 1, 2005. At the interview, applicant's representatives expressed their belief that the Cao reference did not disclose a heat source (the LED array) that generated sufficient heat to activate a heat pipe and thus the addition of a heat pipe would not have been obvious. Applicant's representatives also discussed, as set forth in more detail below, the different functions of the heat sink of Cao and the substrate of the instant invention. Applicant's representatives also discussed the manner in which the LEDs of Mills were attached to a lead frame, which in turn was attached to a terminal, and then to a heat pipe, and further pointed out that the heat pipe of Mills was actually a series of small diameter heat pipes as illustrated in Figure 9. Finally, applicant's representatives expressed their belief that Mills did not disclose a substrate as required by the currently pending claims.

Claims 1, 5-10, 13-21, 25-27, 30-39, 43-48, 51-56, 103 and 104 stand rejected under 35 U.S.C. § 103 as being obvious over Cao (U.S. Patent No. 6,331,111) in view of Mills (WO 99/16136). This rejection is respectfully traversed.

Claim 1 requires, *inter alia*, "a first substrate composed of a material capable of efficiently conducting heat and conducting electrical current, said substrate having a top and a bottom," a "plurality of cups located in said substrate top," at least some "light emitting diodes being firmly mounted in said cups" and a "heat pipe" with a "proximal end being firmly mounted against the bottom of the substrate" and "a heat sink . . . firmly attached to the distal end of said heat pipe."

In contrast to claim 1, Cao discloses a device having a heat sink with a plurality of cups formed therein, and a plurality of LEDs mounted in the cups. Cao's device does not include a heat pipe. Moreover, contrary to the assertion in the office action on page 2, Cao also does not include a separate substrate. The office action cites 702 in Fig. 7 as the substrate and 402b, Fig. 4b as the heat sink. However, Cao's elements 402b and 702 are one in the same thing (albeit in different embodiments); namely, a heat sink. See col. 8, line 48 (referring to heat sink 402b) and col. 10, line 8 (referring to heat sink 702). Both devices have LEDs mounted directly on them. Thus, Cao is lacking two of the required items of claim 1: a substrate and a heat pipe.

The office action asserts that "it would have been obvious to one of ordinary skill in the art to modify Cao to include a heat pipe as shown by Mills in order to better distribute heat away from the heat source." Applicants respectfully disagree with this assertion for two reasons.

First, there is no motivation for such a modification. Cao's LEDs are already mounted directly on a heat sink. Even if the heat pipe were a perfect conductor of heat, the best possible result from the addition of a heat pipe would be that heat would be removed from the LEDs as efficiently as if the LEDs were mounted directly onto the heat sink. However, since no actual heat pipe is a perfect conductor of heat, the actual result of placing a heat pipe between Cao's LEDs and heat sink can only be a *less* efficient transfer of heat away from the LEDs to the heat sink, not a better transfer as asserted in the office action.

Second, the office action does not disclose how the heat pipe of Mills would be integrated into the device of Cao. As discussed above, Cao's device has LEDs mounted directly on a heat sink. Thus, there appear to be two options for integrating Mills' heat pipe

into Cao's device: 1) the heat pipe can be mounted between the LEDs and the heat sink; and
2) the heat pipe may be placed between Cao's existing heat sink and an additional heat sink.

If option 1 were to be used, the question of how the heat from the LEDs would be transferred to the heat pipe arises. Since Cao only discloses mounting LEDs directly to the heat sink, the answer to that question must come from Mills. It should be recognized that Mills and Cao use the term LED differently. In Cao, the term "LED" refers to the semiconductor layers that produce light along with an anode and cathode. In Mills, the term "LED" is used to refer not only to the semiconductor layers (the light emitting PN junction described in Mills at page 6, line 4) that actually produce light and the anode and cathode, but also a lead frame 44 (Mills, page 8, 4th paragraph, second line) to which the anode and cathode are attached and a plastic envelope (element 43 of Figs. 4 and 5) which surrounds the semiconductor layers, the anode and cathode, and a portion of the lead frame 44. The lead frame 44 of Mills is connected to positive and negative terminals or bus bars 42 (Mills, page 8, 4th paragraph, lines 1-3). Thus, in Mills, the "LEDs" (as that term is used in Cao) are connected to lead frames and surrounded by plastic. This arrangement is in stark contrast to claim 1, in which the LEDs are mounted to a common substrate rather than to individual lead frames and surrounded by plastic. Accordingly, option 1 does not result in the invention of claim 1.

There is no motivation for the second option. First, Cao's heat sink presumably has sufficient thermal capacity to handle all of the heat generated by Cao's LEDs. Thus, the addition of a heat pipe and a second heat sink would serve no apparent purpose. Second, attaching a heat pipe to Cao's heat sink would be unlikely to yield any significant heat transfer. It is well known in the art that a heat pipe requires a minimum flux density in order

to activate. However, only a small portion of Cao's heat sink would be in contact with Mills' heat pipe. This would result in a low heat flux density. This problem is exacerbated when one considers the large thermal mass of Cao's heat sink and the resulting lack of efficient heat transfer. Keeping in mind that Cao's heat sink is presumably sufficient to handle the heat generated by Cao's LEDs, it would appear unlikely that there would be sufficient heat flux density transferred to the heat pipe to activate it. For the foregoing reasons, the combination of Cao and Mills does not render obvious the invention of claim 1.

Applicants also wish to call to the examiner's attention to the differences between the substrate of claim 1 and the heat sink of Cao. As can be seen from Fig. 4, Cao's heat sink is not exposed to atmosphere and thus acts as a heat capacitor with a relatively large thermal mass that can absorb and safely dissipate the heat produced by Cao's LEDs. In contrast to Cao's heat sink, the substrate of claim 1 acts not to absorb heat but to rapidly transfer the heat from the LEDs to the heat pipe (see, e.g., reference to heat removing/transporting substrate in paragraph 60 of the present application). Accordingly, there is a significant difference between Cao's heat sink and the substrate of claim 1.

For the reasons stated above, applicants respectfully submit that claim 1 defines patentable subject matter. Independent claims 21 and 38 define patentable subject matter for reasons similar to those discussed in connection with claim 1. All other remaining claims depend from claims 1, 21 or 38 and therefore define patentable subject matter for at least the same reasons discussed above. Accordingly, withdrawal of the rejections of all currently pending claims is respectfully requested.

This application is now believed to be in immediate condition for allowance. The claims present patentable subject matter, and the Examiner is kindly requested to pass this

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Ostler et al.
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application to issue. Should the Examiner wish to discuss this case or have any suggestions to place it into even better condition for allowance, he is kindly invited to contact the Applicants' below-signed representative by telephone at the number provided.

A check in the amount of \$120.00 is enclosed to cover the One Month Extension of Time fee. However, if any additional fee is required, authorization is hereby given to charge Deposit Account No. 07-1896. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

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